Space Weather Technical Forecast

Issued on Wednesday 11 December 2024 at 13:09 Local

This technical forecast provides a four-day assessment of space weather events. The probabilities stated below are for reaching or exceeding the given levels. For more information about space weather impacts please see the Met Office Space Weather Scales https://www.metoffice.gov.uk/weather/learn-about/space-weather/uk-scales

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Space Weather Forecast Headline: Low to Moderate Solar Activity

Analysis of Space Weather Activity over past 24 hours

Solar Activity: Moderate with three M-class flares observed. Peak flare was an M2.7 at 11/1006 from AR3920 in the northeast. This is the most developmental region on the disc, with flux emergence within its southern portion, and currently shows some limited complexity due to its mixed polarity magnetic field. The next most active was AR3922, a small region in the southeast that remains difficult to assess due to its location. This was the source of the other two M-class flares. The other region of note, AR3917 is moderately sized and now moving across the southwest disc, but has been relatively inactive in comparison.

No Earth directed CMEs were observed, although a number of CMEs were visible in imagery. This included those from the M-class flaring to the southeast, passing far south, and a far-sided lift-off from an unknown source viable moving south in imagery. A further narrow CME was also observed off northeast. There was also motion and brightening observed around the large north-south filament in the western disc, however no material was observed erupting. There are a number of other filaments on the Earth-facing disc, however these remained stable.

Solar Wind / Geomagnetic Activity: Mainly slow winds dominated through the period. Solar wind speeds, observed at L1 by ACE were eased from slightly elevated, at just over 400km/s, to be mainly background from 11/1530 UTC, around 350-400km/s. Density was around average. Interplanetary Magnetic Field (Bt) was weak at 5-7nT with the north-south component (Bz) mainly negative (southwards), ranging -6 to +4nT throughout. Phi angle was mainly positive (away from the Sun). Geomagnetic activity was Quiet (Kp 1-2).

Energetic Particles / Solar Radiation: High energy proton flux observed by GOES18 was at background. High energy electron flux (greater than 2MeV) observed by GOES16 showed a diurnal variation from background to moderate, peaking 353 pfu at 10/1725 UTC. The associated 24-hour fluence was below Active, with the 11/0000 UTC observation of 7.44e6 integrated pfu.

Four-Day Space Weather Forecast Summary

Solar Activity: Moderate activity is likely with occasional M-class flares and a slight chance of X-class flares.

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Solar Wind / Geomagnetic Activity: There are no Earth directed CMEs. Background winds are expected to persist with only slight enhancements possible from any interaction with the fast wind from CH98 across the north disc. The next main fast wind onset is likely to be from CH99, on day 4 (14 Dec) or just beyond this period on day 5 (15 Dec). Geomagnetic activity is forecast to be Quiet with a chance of isolated Unsettled intervals. This increasing to give Unsettled to Active, with a slight chance of G1 Minor Storm intervals on day 4 (14 Dec) if any connection to CH99 occurs.

Energetic Particles / Solar Radiation: High energy proton flux is expected to remain at background with only a slight chance of rising in response to any notable flares. High energy electron flux is expected to persist at background to moderate, but likely dropping out to persistently background if any fast wind onset occurs on day 4 (14 Dec). The 24-hour fluence is expected to remain below the Active threshold.

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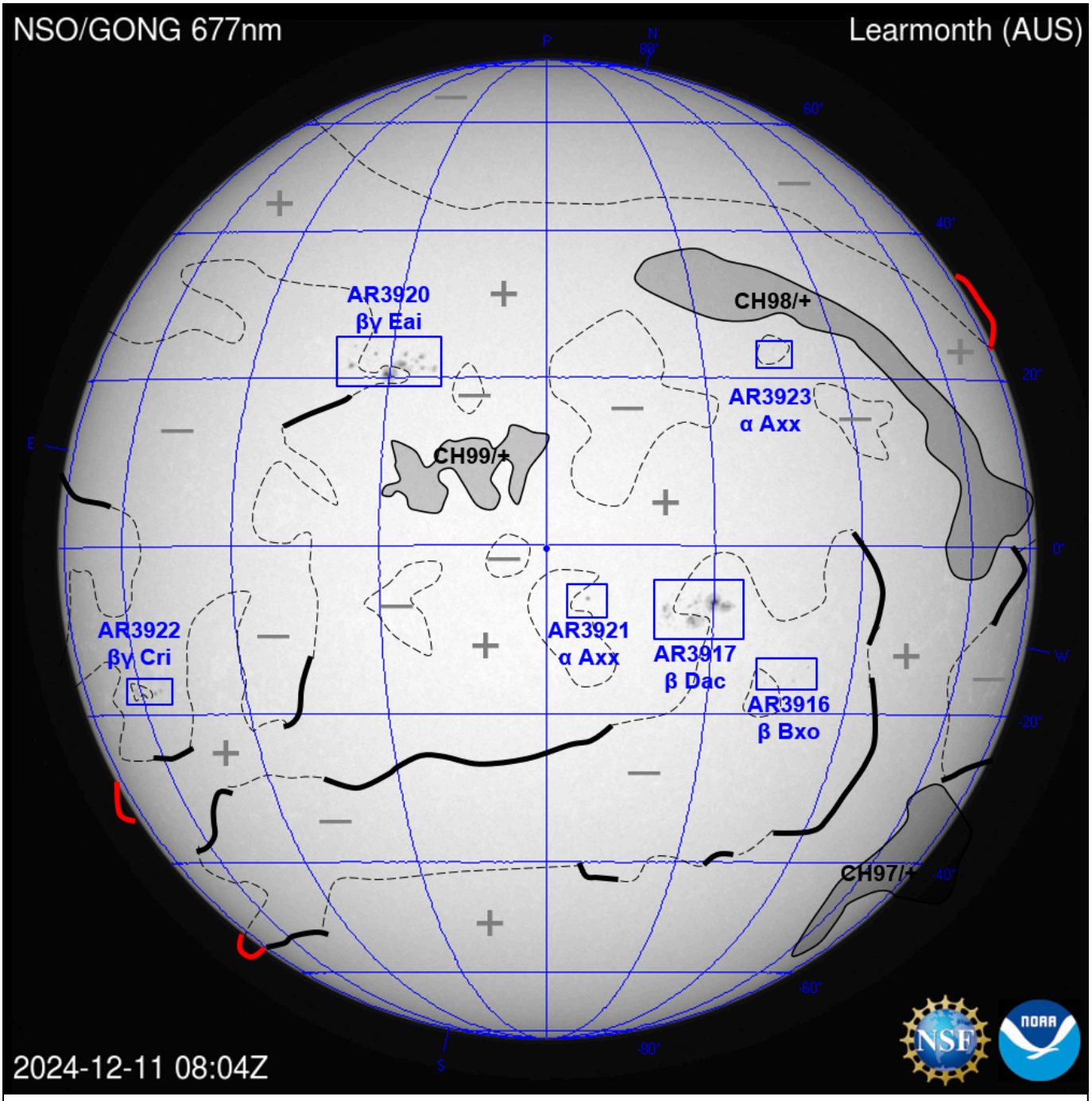
Figure 1: MOSWOC Solar Synoptic Map 11/0800 UTC



Key: Filament ___ , Prominence ___ , Magnetic Field Line - - - , Polarity +/-, Coronal Holes: Grey shaded area CHxx +/-, Sunspot groups 25xx - Mt Wilson α-β-βγ-βγδ and Zurich-McIntosh Axx etc.

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Geomagnetic Storms

There are no Earth-directed CMEs.

Fast winds from the connection to the southern lobe of CH98 look to have largely passed with solar winds largely at background speeds. While CH98 is extended eastward across the northern disc, any further connection is likely to be minimal, bringing just a chance of brief periods of slightly elevated solar winds.

The next enhancement is expected from the fast winds of CH99, which is currently approaching the centre disc. This is a persistent feature, and was likely the cause of a weak enhancement that occurred on the previous rotation on 18 Nov. This resulted in winds speeds of around 450 km/s, and would map to this rotation to give an arrival on day 5 (15 Dec) and perhaps earlier if a stronger fast wind is observed. Enlil is currently showing a weak enhancement on 14 Dec, however this also suggests Earth will continue to see a weak connection to CH98 for much of the period, which is not agreeing with observation, leading to very low confidence in this guidance. It is also possible that this indicated enhancement is due to Enlil's handling of CH98, rather than from CH99.

Overall, mainly Quiet geomagnetic activity is expected with a chance of isolated Unsettled intervals. This increasing to give Unsettled to Active, with a slight chance of G1 Minor Storm intervals on day 4 (14 Dec) if any connection to CH99 occurs.

Geomagnetic Storm Probability (Exceedance)	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Minor or Moderate	G1 to G2	No	1	1	1	10
Strong	G3	No	1	1	1	1
Severe	G4	No	1	1	1	1
Extreme	G5	No	1	1	1	1

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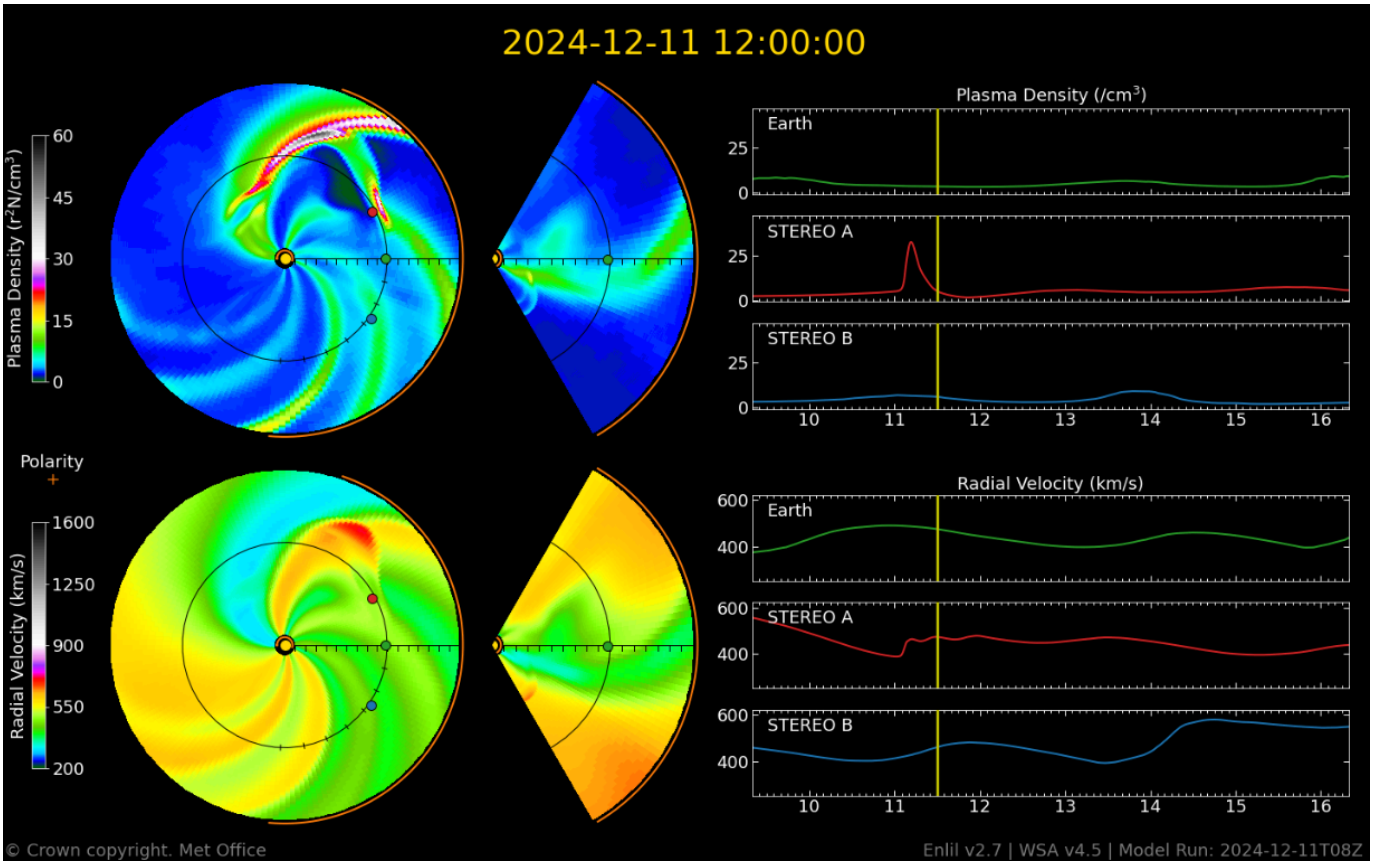
Figure 2: MOSWOC Enlil



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Radio Blackouts - X-Ray Flares

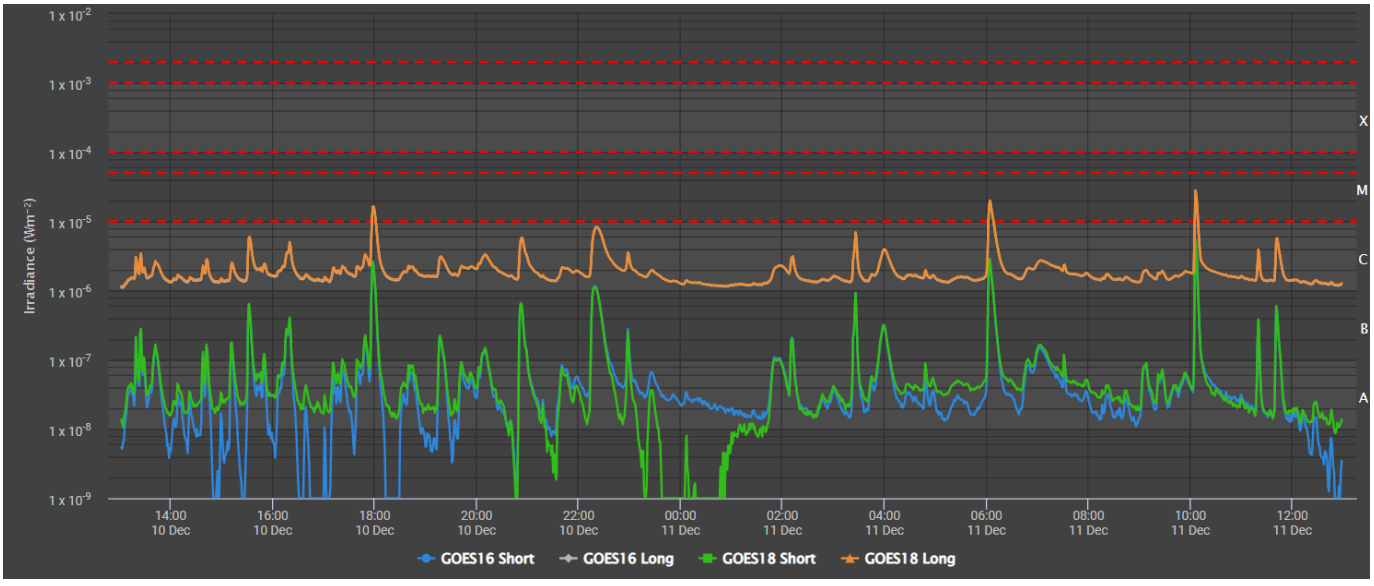
There are six active regions currently on the disc, however three of these have the potential for notable flares., giving an overall likelihood of further M-class flares with a very slight chance of an X-class flare.

AR3922 in the southeast has seen occasional M-class flaring through the last 48 hours, including a peak flare of M6.4 on 10 Dec. However, this remains a small and apparently relatively simple region, although some complexity is becoming apparent as this moves into a clearer viewing angle. The largest region is AR3917, now moving across the southwest disc, however this has shown some consolidation of its smaller spots into a few larger ones. AR3920, which has also seen frequent C-class flaring along with providing the peak M-class flare in the last 24 hours, has been developing through the last 24-48 hours with ongoing flux emergence and increase in penumbral extent. This has also developed some slight magnetic complexity.

GOES SUVI imagery also shows the potential for oncoming region or regions onto the the southeast disc, with a collection of strong field lines evident on SUVI 171, along with some bright returns on SUVI 284, however this is low confidence.

X-Ray Flares	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability			(%)	(%)	(%)	(%)
Active	R1-R2 (M Class)	Yes	70	65	60	60
Very Active	R3-R5 (X Class)	No	10	10	5	5

Figure 3: GOES16/18 X-ray Irradiance



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Solar Radiation Storms (High Energy Protons)

GOES18 proton flux is currently at background, and is expected to persist at this level, with only a very slight chance of rising in response to any notable flares. This risk perhaps increasing later in the period as the current regions, including AR3917 and AR3920 move into and across the better connected western hemisphere.

Radiation Storms Probability (Exceedance)	Level ($cm^{-2}sr^{-1}s^{-1}$)	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ S1**	No	5	5	5	10
Very Active	**≥ S3 ***	No	1	1	1	1
* S3 ≥ 10 MeV ≥ 1000 pfu and/or 50 MeV ≥ 10pfu. (pfu = $cm^{-2}sr^{-1}s^{-1}$)						

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High Energy Electrons (≥ 2MeV)

High energy Electron flux observed by GOES16 showed a diurnal increased from background levels to moderate with a similar trend likely to continue. Recent solar wind enhancement from the fast wind of CH98 was relatively subdued in terms of geomagnetic activity, despite peaking at around 500 km/s. This likely limited the charging of the Van Allen Belts, and any subsequent electron flux that will be observed through this period. Subsequently Background to Moderate flux is expected, perhaps approaching High at diurnal peaks. Any arrival of the fast winds of CH99 later in the period will likely drop out values at GEO, to mainly background.

The associated 24 hr fluence is expected to remain below Active. The MOSWOC REFM forecast is currently underestimating the expected fluence, with a slight upward trend more likely, however this supports the overall fluence forecast for fluence to remain below Active.

GEO Electron Environment	Level ($cm^{-2}sr^{-1}$ day^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability (Exceedance)			(%)	(%)	(%)	(%)
Active	≥ 2 MeV ≥ 1×10^{8}	No	1	1	1	1
Very Active	≥ 2 MeV ≥ 1×10^{9}	No	1	1	1	1

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Figure 4: GOES16 >2MeV Electron Flux (top) and associated 24 hr fluence with REFM and Recurrence (bottom)

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